Extra Class License Manual – Supplemental Information and Errata

The following text is intended to support or correct the 13th edition of the *Extra Class License Manual* and the 6th edition of the *Extra Class Q&A*.

Determine the version of the manual you are using by referring to the first page of the preface inside your copy. Look for the text box with the copyright information where you'll also find the edition and printing information. (If the edition number is not followed by printing information, the book is the first printing.) If the material does not refer to a specific printing, it applies to all versions of the manual.

The question pool for the current Extra Class license takes effect on July 1, 2024.

Question Pool Changes

E9E10 — This question has been withdrawn.

Supplemental Information

Extra Class License Manual

Significant Digits in Answers: Students may be confused when making calculations because the answer in the question pool or example does not reflect the exact number produced by a calculator. A tutorial on significant digits is available online at **chemcollective.org/activities/tutorials/stoich/significant_figures** as well as through the online Khan Academy (**www.khanacademy.org**). Although the question pool is not completely consistent regarding significant digits in calculations, the student should expect answers to be rounded or refer to "best representations" to accommodate different methods of calculation. The associated question to this calculation (E5C11) asks only which of the graphed points "best represents" the resulting impedance, for example. High precision is not required in any exam question.

Chapter 2

Page 2-3

The essential reason for the bureau system (http://www.arrl.org/incoming-qsl-service) was postage costs and postal system reliability when it was devised. Before Logbook Of The World became so popular, most QSLing was by paper cards. Within the US, a postcard stamp wasn't so costly but to send international mail was much more expensive, especially if you sent return postage and an SASE. It costs well over a dollar to send a card even without return postage! An active station could easily spend hundreds or thousands of dollars on postage if all QSLs were sent direct. Volume is way down these days but there are still a lot of paper cards going back and forth. Getting a paper card from a new station is a lot of fun, as you probably know. So, many stations will send a paper card for a first contact and then rely on the electronic systems for subsequent QSOs.

Chapter 4

Page 4-13

In the paragraph labeled 0° to 90°, the intent was to note that at 0° the voltage is zero, so a better beginning sentence might be, ""Voltage is zero at 0 degrees, so no energy is stored in the capacitor."

Page 4-19

Covered in the General exam, remember that conductance is represented by G and is the reciprocal of resistance so that $G = 1/R$.

Page 4-28

Figure 4.24 shows the intersection of two lines representing reactance vs frequency: the curved line, decreasing to the right, shows capacitive reactance $X_C = 1/2\pi fC$, and the straight line rising to the right shows inductive reactance $X_L = 2\pi fL$. At the frequency where the lines cross, $X_C = X_L$ and the circuit is resonant. The scales of both axes are linear, resulting in the curved and straight lines. In most engineering manuals and texts, however, reactances are plotted on a log-log chart where both types of reactance are plotted as straight lines. This makes it a lot easier to see where the resonant frequency is for a wide range of capacitance, inductance, and frequencies. You can see this kind of chart in the Electrical Fundamentals chapter of the *ARRL Handbook* or online at **www.rfcafe.com/references/electrical/frequency-reactance-nomograph.htm**.

Chapter 5

Page 5-21

The description of the XOR function wasn't clear: the output will be 0 if both inputs are 0 or if both inputs are 1. The output of the XOR gate is 1 if one and only one of the inputs is 1. The exam question E7A09 asks about the XNOR function which inverts the XOR outputs so that the output is 0 if one and only one of the inputs is 1.

Page 5-23

In Figure 5.38 - the first line of the state table (B) for S = 0 and R = 0 is saying "If S and R are both zero, the states of the Q and not-Q outputs are unchanged."

In the bottom line of the truth table, the output states are uncertain for S = 1 and R = 1 because both Q and not-Q attempt to go to the *same* state, which is not allowed for complementary outputs. Either 0 or 1 would possible - see **https://en.wikipedia.org/wiki/Flip-flop_(electronics)**. Whether it is 0 or 1 depends on exact timing of signal changes and similar concerns. This is one reason why the S-R flip-flop isn't often used in favor of a clocked D-type or J-K flip-flop.

Chapter 6

The symbol // (two parallel slashes) is used to mean "in parallel with" instead of showing the full equation for the paralleled components. Using // is often clearer than the full equation when attempting to explain a design or relationship.

Page 6-13

In Figure 6-12, the symbol β (beta) is used to represent the feedback ratio through the feedback network. While this is standard terminology (**en.wikipedia.org/wiki/Barkhausen_stability_criterion**), beta is also used to represent the ratio of collector to base current in a bipolar transistor. The context of the discussion should be used to alert the reader which meaning of the symbol is used. There are many symbols with multiple uses in electronics – caution is advised, along with a good glossary.

Page 6-15

Clarifying the RF Oscillators section's first paragraph, what Hartley and Colpitts came up with was two different ways in which feedback and a filter could be combined with an amplifier to make an oscillator. (see Figure 6.12 for the general case) In the case of Figure 6.14A and B, the amplifying device is a transistor although when the original circuits were invented, only vacuum tubes were available.

Page 6-38

The phrase *"As a pulse becomes narrower and narrower, its frequency spectrum spreads out more and more"* can be hard to understand. Without getting into the full mathematics of the spectrum of pulses, we can simplify the reasoning a bit as follows: As the pulse becomes narrower in time, higher and higher frequency components are required to make the sharp edges with the short duration between them. At the extreme, the spectrum of a zero-width impulse has components at <u>all</u> frequencies. This is why impulse noise, such as from arcs and spark discharges, has such a wide spectrum and creates interference across a wide frequency range. Similarly for key clicks - the sharper the keying, the worse the clicks become.

Page 6-43

The function of the linear regulator circuit on the exam (Figure E7-2) is easier to understand if both Figure 6.46 and Figure E7-3 are available while reading the explanation of the circuit's function on page 6-45. The schematic in Figure 6.46 is more typical of an actual linear regulator than the exam figure which is somewhat oversimplified.

Chapter 7

Page 7-17

The maximum input signal level that can be digitized correctly is established by the converter's reference voltage. Some converters use an external reference voltage and others have an internal voltage reference.

Chapter 9

A resonant antenna has a feed point impedance that is all resistance. i.e. $Z = R + j0$. Yet the current and voltage appear to be 90 degrees out of phase at resonance – why?
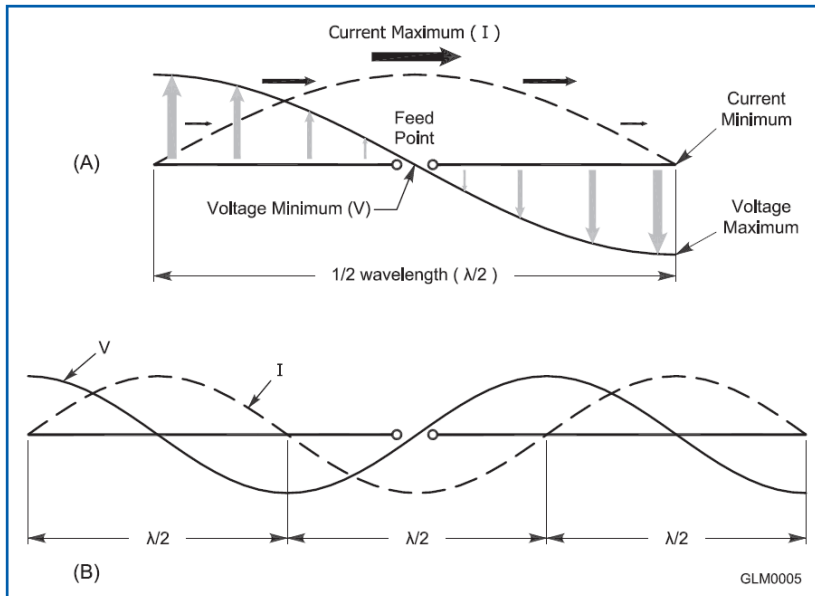
The drawing above shows the current and voltage distributions. The distributions along the wire are just the magnitude of the waveforms (like the envelope of a modulated signal) and doesn't say anything about the phase of the actual waveform. It is the distributions that are 90 degrees out of phase, not the waveforms. At the center, the voltage waveform reaches a minimum while the current waveform is at a maximum - yet both waveforms are in-phase (at resonance), resulting in a purely resistive impedance.

Page 9-23

Figure 9.22 – all antennas are installed in the vertical plane.

Page 9-26

In Equation 9.4B, because System Gain is given in dB, the anti- or inverse log function must be used to calculate ERP in watts. $\log^{-1}(x)$ is also the same thing as 10^x.

Page 9-29

The parasitic arrays referred to in the discussion of gamma matches are most often Yagi or quad antennas.

Page 9-30

In the explanation of the function of the hairpin inductor, it is correct that the hairpin is a shunt inductor. [**E9E05**] This shunt inductor then combines with the capacitive reactance of the antenna's driven element to form an L network, matching the antenna's feed point impedance to 50 ohms.

Page 9-33

In Example 9.10, the question pool's correct answer for E9F06 does not take into account the velocity factor for the specified feed line (VF = 0.95 to 0.99). However, 10.6 meters (C) is the closest answer, satisfying the question's "approximate length" wording.

Errata

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Pages 1-9 and 1-12

These pages state that the glossary appears before the question pool. It should state that the glossary is available on the ECLM website **www.arrl.org/extra-class-license-manual**.

2-5

The answer beneath the question E2C03 was given incorrectly as 70 centimeters. It should be 30 meters.

Page 4-16

The reference to question [E502] should have appeared at the end of the fourth paragraph instead of at the end of the first. The answer to the question relates to polar, not rectangular coordinates.

Page 4-26

The reference to question [E5D15] should be deleted.

Page 4-27

The reference to question [E5D07] should be deleted.

Page 4-32

The reference to question [E5A15] should be deleted.

Page 4-33

The reference to question [E5A10] should be deleted.

Page 5-24

In equation 5.7 – the denominator should be $C_1[R_1 + (2 \times R_2)]$

Page 5-26

Question E6C09 was omitted from the list of questions and answers. It should have been given as:
What is used to design the configuration of a field-programmable gate array (FPGA)?
Hardware description language (HDL)

Page 6-36

A band-pass filter's shape factor is the ratio of the filter's wide bandwidth at the –60 dB level to narrow bandwidth at the –6 dB level, so the calculation of shape factor should be 5.4 / 1.8 = 3.0.

Page 6-42

Figure 6.43 – the caption should read "…to the antenna's impedance…"

Page 9-3

In equation 9.2, change 2.5 dB to 2.15 dB as in equation 9.1.

Page 9-20

The incorrect answer was given for question E9D11. It should be "Higher gain."

In the section on Yagi Antennas the last sentence of the third paragraph should read, "To the front of the antenna, the extra travel time for the reradiated signal from the reflector causes it to reinforce the DE signal. [**E9D11**]

Page 9-27

Example 9.6 calculates EIRP (effective isotropic radiated power).

Page 11-6

The question reference [**E0A02**] was omitted from the end of the first sentence of the third paragraph.

Page 12-51

The page number for question E6C09 was omitted. It should be 5-26.

Page 12-80

The answer to question E9A09 was given incorrectly as (B). It should be (A).

Errata

ARRL Extra Class Q&A

Page 5

The answer to E1A05 was given incorrectly as B. It should be C.

Page 13

The answer to E1C07 was given incorrectly as C. It should be D.

Page 61

The answer to E3C09 was given incorrectly as B. It should be D.